# RECORDING APPARATUS

## Background of the Invention

### 1. Field of the Invention

This invention relates to a recording apparatus for forming images on a recording medium.

### 2. Description of Related Art

The quality of output images produced by a recording apparatus, particularly an inkjet recording apparatus, is desired to be improved significantly, and a higher accuracy is needed to realize this. In order to improve image quality of a recording apparatus, an ink discharging amount can be reduced to lower a particulate feeling of dots of discharged ink as images and the dot size on the recording medium tends to be smaller. Where the dot becomes smaller, a region, where otherwise the dots would be overlapped with one another, enters in a state of no overlapping if the dot arrival position is changed even a little (or conversely, a region not to be overlapped becomes overlapped), so that the density and color tone of the region may be shifted. Such shifts in density and color tone render inferior the image quality by causing white or black stripes in images or unevenness in color. The positional shifts among the dots here are of a level from several microns to tens of microns, and means for ensuring this accuracy has been used.

With respect to conveyance mechanisms for a recording medium as one of important mechanisms for image formation, drive structures or the like have been proposed and used for keeping an assembly accuracy as a structure canceling stop errors of a motor or eccentric accuracy components of gears by rendering the level of the parts highly accurate, e.g., improving eccentricity, cylindrical degrees, and allowable diameter deviations of conveyance rollers and classes of the gears and by rendering the conveyance amount to coincide with integer multiples of the dimensions of the motor and the gears. A method, in addition to the accuracy consideration of an ideal rotary amount (conveyance surface moving amount) of the conveyance roller, is also used in which micro protrusions are formed on an outer peripheral surface of bearings to stabilize the position of the bearings for supporting the conveyance roller for the purpose of prevention of positional shifts of the conveyance roller itself and in which any deviation between the bearing of the conveyance roller and the chassis otherwise generated on an allowance is eliminated by inserting the bearing so as to grind those protrusions when the bearing is attached to the chassis.

With such a conventional means, however, though the accuracy in the ideal rotary amount (conveyance surface moving amount) of the conveyance roller is adequately considered, a solution regarding the position of the conveyance roller is inadequate. Fig. 10 shows a bearing structure for a general conveyance roller. In Fig. 10, numeral 1001 denotes a conveyance roller; numeral 1002 denotes a bearing; numeral 1003 denotes a chassis supporting the bearing; and numeral 1004 denotes a pinch roller. The pinch

roller 1004 is pushed to the conveyance roller 1001 with force Fp from a spring (not shown) to produce a conveyance force for recording media.

The conveyance roller 1001 is structured as to move easily in Y, Y' directions on an inner circumference of the bearing 1002 because the cross-sections of the conveyance roller 1001, the bearing 1003, and the chassis 1003 are in a circular shape, respectively, even where positional deviations between the conveyance roller 1001 and the bearing 1002 and between the bearing 1002 and the chassis 1003 are accumulated together in the downward direction in Fig. 10 by pushing force Fp from the pinch roller 1004, and the bearing 1002 is also structured as to easily move in the Y, Y directions where the relation between the chassis 1003 and the bearing 1002 is the same as the above, so that the conveyance roller 1001 easily moves upon exertion of external force from external disturbances and so that the position of the conveyance roller 1001 is statically unstable with respect to the chassis 1003.

In the above-described method, as conventional art, in which micro protrusions are formed on the outer peripheral surface of the bearing and in which the bearing 1002 is inserted as these protrusions are ground when the bearing 1002 is attached to the chassis, though positional deviations are eliminated when the bearing 102 is inserted, the protrusions have to be easily ground, namely to be weak protrusions, because the protrusions are necessarily of a degree not to deform the inner diameter of the bearing during insertion of the bearing, so that the protrusions may be deformed due to falling during transportation or vibrations, thereby creating positional deviations. In general, there are differences in thermal expansion property among the bearing made of

a resin such as POM or the like, and the chassis and the conveyance roller shaft, which are made of a metal, so that problems are raised such that the size may vary from changes in temperature and thereby positional deviations may occur.

**Summary of the Invention**

It is an object of the invention to provide a recording apparatus preventing a recording medium from moving due to movement of a conveyance roller by stabilizing the position of the conveyance roller and a bearing without any cost increase as well as improving accuracy of arrival positions of ink droplets.

To accomplish the above object, a representative structure according to the invention includes, in a recording apparatus: a conveyance roller; a driven roller rotating as driven from the conveyance roller; pushing means for pushing the driven roller to the conveyance roller; a bearing for supporting the conveyance roller; driving means for rotating the conveyance roller; and drive transmitting means, wherein the bearing includes two contact portions for supporting the circumference of the conveyance roller, and wherein the bearing supports the conveyance roller as to locate a perpendicular direction of a line segment coupling the two contact portions within a varying range of a vector direction of exertion force exerted to the bearing at a time of stop and operation of the conveyance roller.

As described above, in this invention, because a recording apparatus includes: a conveyance roller; a driven roller rotating as driven from the

conveyance roller; pushing means for pushing the driven roller to the conveyance roller; a bearing for supporting the conveyance roller; driving means for rotating the conveyance roller; and drive transmitting means, wherein the bearing includes two contact portions for supporting the circumference of the conveyance roller, and wherein the bearing supports the conveyance roller as to locate a perpendicular direction of a line segment coupling the two contact portions within a varying range of a vector direction of exertion force exerted to the bearing at a time of stop and operation of the conveyance roller, it can prevent a recording medium from moving due to movement of a conveyance roller by stabilizing the position of the conveyance roller and a bearing without any cost increase as well as improve accuracy of arrival positions of ink droplets.

Brief Description of the Drawings

Fig. 1 is a perspective view showing an inkjet printer according to the first embodiment of the invention;

Fig. 2 is a structural diagram showing a conveyance roller and a bearing according to the first embodiment of the invention;

Fig. 3 is an illustration showing force exerting on the conveyance roller and the bearing according to the first embodiment of the invention;

Fig. 4 is an illustration showing the conveyance roller's force exerting on the bearing at respective states during driving according to the first embodiment of the invention;

Fig. 5 is a relation diagram between the contact portion of the

bearing and bearing exerting force according to the first embodiment of the invention;

Fig. 6 is a schematic view showing a shape of the bearing according to the first embodiment of the invention;

Fig. 7 is a structural diagram showing a conveyance roller and a vicinity of a bearing according to the second embodiment of the invention as well as an illustration showing exerting force;

Fig. 8 is a schematic view showing a shape of a chassis according to the second embodiment of the invention;

Fig. 9 is a structural diagram showing a conveyance roller and a vicinity of a bearing according to the third embodiment of the invention; and

Fig. 10 is a structural diagram showing a conveyance roller and a vicinity of a bearing of a prior art apparatus.

## Detailed Description of the Preferred Embodiments

### [First Embodiment]

Now, the first embodiment is described. In this embodiment, exemplified is a serial type inkjet printer on which a recording head as a recording means with a detachable ink tank is mounted. Fig. 1 is a diagram showing the entire serial type inkjet printer. In Fig. 1, numeral 101 is a recording head having an ink tank; and numeral 102 is a carriage mounting the recording head thereon. A guide shaft 103 is inserted at a bearing portion of the carriage 102 in a state capable of sliding in a main scanning direction perpendicular to the conveyance direction of a recording medium 301, and

each end of the shaft is secured to a chassis 116. Drive force of a drive motor 105 serving as a carriage driving means is transmitted to the carriage 102 via a belt 104 serving as carriage drive transmitting means engaged thereto, and thereby the carriage 102 is movable in the main scanning direction (X direction).

In Fig. 1, numeral 106 is a feeding base for stacking the recording media; numeral 107 is a conveyance motor as a drive source for conveyance of the recording media; numeral 108 is a conveyance roller for conveying the recording media (in this embodiment, the conveyance surface of the conveyance roller for the recording media and the bearing supporting portion are considered to have the same diameter, and hereinafter, the conveyance roller and the conveyance roller shaft as a spindle (supporting axis) of a conveyance roller are described as having the same meaning.); numeral 109 is a bearing for supporting a shaft of the conveyance roller 108 at the opposite ends of the conveyance roller 108 and is attached to the chassis 116; numeral 110 is a conveyance roller gear for transmitting the drive force of the conveyance motor 107 and is attached to the conveyance roller 108; numeral 111 is a pinch roller for pressing the recording media to the conveyance roller 108; and numeral 112 is a pinch roller spring serving as pressing means for pressing the pinch roller.

The recording media during waiting time for printing are stacked on the feeding base 106, and the recording media are fed at the beginning of the printing operation by a feeding roller (not shown). The recording media thus fed are conveyed by a proper feeding amount in a conveyance direction of Y

upon rotation of the conveyance roller 108 from the drive of the conveyance motor 107 for the recording media. Images are thus formed by discharging ink or inks to the recording media from the recording head 101 during the scanning operation of the carriage 102. The media are delivered by the delivering means after images are formed, and the recording operation is completed.

In this embodiment, as an ink discharging structure, an electro-thermal converter is energized in response to a recording signal to make recording by discharging the inks from orifices upon growth and contraction of bubbles generated in the inks in utilizing film boiling generated in the inks from the thermal energy thereof. As a representative structure and principle, it is preferable to used a fundamental principle disclosed in U.S. Pat. Nos. 4,723,129, and 4,740,796. This method is applicable to any of so-called on-demand and continuous types, but particularly, upon applying at least one drive signal providing rapid temperature increase exceeding nucleate boiling and corresponding to the recording information to the electro-thermal converter disposed as to correspond to a sheet to which a fluid (ink) is held or to a fluid route, and thereby generating thermal energy at the electro-thermal converter to generate film boiling at a thermal operative surface of the recording head, the on-demand type is effective because bubbles can be consequently formed in a fluid corresponding, on a one to one basis, to the drive signal. With growth and contraction of the bubbles, the fluid is discharged out of discharging openings, and at least one droplet is formed. If the drive signal is formed as a pulse shape, the growth and contraction of the

bubbles can be done instantly, so that the fluid can be discharged excellently, and therefore it is preferable.

Fig. 2 shows a structure of the conveyance roller 108 and the bearing 109. The pushing force of the pinch roller 111 is here exerted to the conveyance roller 108 by an elastic force of the pinch roller spring 112. On the other hand, the bearing 109 has two surfaces supporting the conveyance roller 108, and therefore, tangents (contact points when seen in the cross-section) 109a, 109b exist between the two surfaces and the conveyance roller 108. With this structure, the conveyance roller 108 is supported only by the two portions, defined geometrically, of the bearing 109, and because the conveyance roller 108 is positionally set by the tangents 109a, 109b in the conveyance direction (Y, Y' direction in Fig. 2), the conveyance roller 108 does not move positionally in the conveyance direction (Y, Y' direction in Fig. 2) as long as the conveyance roller 108 does not float from the bearing 109. The bearing 109 is fastened to the chassis 116 with a rotary limiting portion (not shown) and does not move pivotally with respect to the chassis 116. It is to be noted that the assembling property can be improved by providing an opening capable of receiving in a radial direction the conveyance roller 108 with respect to the bearing 109 or the bearing 109 with respect to the chassis 116. The two surfaces supporting the conveyance roller 108 can be any shape, but a plane is preferable.

Fig. 3 is an illustration showing forces exerting on the conveyance roller 108 and the bearing 109. The meanings of the reference characters in Fig. 3 are as follows:

Fp: pushing force of the pinch roller

Fb: conveyance resistance force

Ff: conveyance roller drive force

Fg: gravity force of the conveyance roller

N1, N2: opposing force of the bearing (vertical opposing force)

$\mu$N1, $\mu$N2: frictional force between the conveyance roller shaft and the bearing

$\theta$f: positional angle of the drive gear

$\theta$1, $\theta$2: contact positional angle with respect to the conveyance roller and the bearing

$\alpha$: pressure angle of the drive gear

R: radius of the conveyance roller gear

r: radius of the conveyance roller

T: acceleration torque of a rotary body in relation to the conveyance roller

In Fig. 3, numeral 107a is an output gear (conveyance motor gear) for the conveyance motor and engages with a conveyance roller gear 110 at a position shifted by angle $\theta$f with respect to a perpendicularly lower direction of the conveyance roller gear 110. The gear 107a is a drive transmitting means for driving the conveyance roller 108, and transmits force Ff rotating the conveyance roller gear 110. Generally, in a case of gear transmission, drive force Ff exerts in a direction shifted by pressure angle $\alpha$. from the common tangent direction of the conveyance motor gear 107a and the conveyance roller gear 110. Pushing force Fp of the pinch roller 111 from the elastic force of the pinch roller spring 112 is exerted to the conveyance roller 108 in a perpendicularly downward direction.

The recording medium 301 to be conveyed is sandwiched between the conveyance roller 108 and the pinch roller 111. Conveyance resistance such as rigidity of the recording medium is exerted to the recording medium 301 to be conveyed in a direction of conveyance upstream or downstream, and conveyance resistance force Fb dealt as a resultant force with a rolling friction of the pinch roller 111 is exerted to the conveyance roller 108 in a direction opposite to the conveyance direction (right direction in Fig. 3). This conveyance resistance force Fb is frictional resistance occurring when the conveyance roller 108 is moving or when the force to move is exerted. The outer peripheral surface of the conveyance roller 108 (the conveyance roller shaft) is supported by contact with the two contact portions 109a, 109b at the bearing, and opposing forces Nl, N2 of the force supporting the conveyance roller 108 are exerted in a radially inward direction of the conveyance roller 108 at the contact portions l09a, 109b.

The contact portions l09a, 109b are respectively in contact with the conveyance roller 108 at positions of angles $\theta 1$, $\theta 2$ from the perpendicularly downward direction. At the contact portions l09a, 109b, frictional resistances in a tangent direction opposed to the rotation direction of the conveyance roller 108 are exerted with forces $\mu N1$, $\mu N2$ ( provided that the frictional coefficient is $\mu$ between the conveyance roller 108 and the bearing 109). When the conveyance roller 108 is accelerated or decelerated, the acceleration torque $T = Id\omega/dt$ (I denotes inertia of the rotary body (moment of inertia); $\omega$ denotes an angular velocity of the rotary body) of the rotary body in association with the conveyance roller 108 is exerted.

Herein, where:

$A = \sin\theta 1 + \mu \cos\theta 1$,

$B = -\sin\theta 2 + \mu \cos\theta 2$,

$C = \cos\theta 1 - \mu \sin\theta 1$,

$D = \cos\theta 2 + \mu \sin\theta 2$,

$E = Fb + Ff \cos(\theta f - \alpha)$

$F = Fg + Fp + Ff \sin(\theta f - \alpha)$,

vertical opposing forces that the bearing 109 receives are denoted as:

$Nl = (DE - BF) / (AD - BC)$,

$N2 = (AF - CE) / (AD - BC)$.

Furthermore, where:

$G = (\sin\theta 1 + \mu \cos\theta 1)N1 - (\sin\theta 2 - \mu \cos\theta 2)N2$,

$H = (\cos\theta 1 - \mu \sin\theta 1)N1 + (\cos\theta 2 + \mu \sin\theta 2)N2$,

force Fv (scalar) that the conveyance roller 108 exerts to the bearing 109 is:

$Fv\ (\text{scalar}) = \sqrt{(G^2 + H^2)}$,

and the exertion angle $\theta v$ is:

$\theta v = \tan^{-1}(G/H)$,

and at that time, acceleration torque T is denoted as:

$T = RFf \cos\alpha - rFb - r\mu(N1 + N2)$.

Hereinafter, referring to Fig. 4, the force Fv (vector), which the conveyance roller 108 exerts on the bearing 109 while the conveyance roller 108 is in a state of stopping (without drive force), starting up, accelerating, moving at a constant rate, decelerating, and immediately before stopping, is described.

Where: Fv during stopping is Fv0, T is T0, and drive force Ff is Ff0, it is set as Ff0=0, Fb=0, $\mu$Nl=0, $\mu$N2=0, T0=0, and Fv0 becomes a vector directing perpendicularly downward ($\theta v = 0$).

Where: force Fv exerting on the bearing 109 during starting up is Fv1, acceleration torque T is Tl, and drive force Ff is Ff1, it is set as $\mu$ = static frictional coefficient and Fb is the maximum static frictional force, and Fv1 becomes a vector extending in a direction inclined by angle $\theta$v1 from the perpendicularly downward direction in association with the drive force Ffl at which Tl = 0.

Where the force Fv exerting on the bearing 109 during acceleration is Fv2, acceleration torque T is T2, and drive force Ff is Ff2, it is set as $\mu$ = dynamic frictional coefficient and Fb is the dynamic frictional force, and Fv2 becomes a vector extending in a direction inclined by angle $\theta$v2 from the perpendicularly downward direction in association with the drive force Ff2 at which T2 > 0. The magnitude and direction of this vector is changeable according to the drive force Ff2 (or according to T2).

Where the force Fv exerting on the bearing 109 during moving at a fixed rate is Fv3, acceleration torque T is T3, and drive force Ff is Ff3, it is set as $\mu$ = dynamic frictional coefficient and Fb is the dynamic frictional force, and Fv3 becomes a vector extending in a direction inclined by angle $\theta$v3 from the perpendicularly downward direction in association with the drive force Ff2 at which T3 = 0.

Where the force Fv exerting on the bearing 109 during deceleration is Fv4, acceleration torque T is T4, and drive force Ff is Ff4, it is set as $\mu$ =

dynamic frictional coefficient and Fb is the dynamic frictional force, and Fv4 becomes a vector extending in a direction inclined by angle $\theta v4$ from the perpendicularly downward direction in association with the drive force Ff4 at which $T4 < 0$. The magnitude and direction of this vector is changeable according to the drive force Ff4 (or according to T4).

Where the force Fv exerting on the bearing 109 at a time immediately before stopping is Fv5, acceleration torque T is T5, and drive force Ff is Ff5, it is set as $\mu$ = dynamic frictional coefficient and Fb is the dynamic frictional force, and Fv5 becomes a vector extending in a direction inclined by angle $\theta v5$ from the perpendicularly downward direction in association with the drive force Ff5 at which $T5 < 0$.

To reduce impacts at stop, the acceleration torque T5 is generally set to be a value close to zero at the time immediately before stopping ($T5 > T4$). To prevent gears from backlashing from a viewpoint of gear transmission accuracy, it is preferable that the drive gear reduces its rate always while pushing the conveyance gear during deceleration, and generally the drive forces of $Ff4 > 0$, $Ff5 > 0$ are set.

Therefore, a relationship of $\theta v1>\theta v4>\theta v5>\theta v3>\theta v2>\theta v0$ is satisfied in a setting of acceleration during general acceleration and deceleration period, from relations of static frictional coefficient > dynamic frictional coefficient, $T2>T1 = T3 > T5 > T4$, $Ff4> 0$, and $Ff5 > 0$. According to this relation, the starting up vector Fv1 and the stopping vector Fv0, existing at both extremes, are preferably stabilized to render the conveyance roller 108 settled at a stable position during operation inclusive of the stopping

state.

As shown in Fig. 5, where the combined vector of vectors Fv1 and Fv0 is set as Ft, Ft becomes a vector extending in a direction inclined by angle $\theta t$ from the perpendicularly downward direction. The contact portions 109a, 109b for the conveyance roller 108 and the bearing 109 are formed at positions in symmetry with respect to a direction of angle $\theta t$ of the vector Ft (namely, the contact positional angles $\theta 1$, $\theta 2$ are determined so that the angle $\theta t$ direction of the vector Ft and the direction perpendicular to the line segment coupling the two contact positions 109a, 109b coincides with each other). Because Ft and $\theta 1$, Ft and $\theta 2$ are in a dependent relation with one another, the conveyance roller 108 can be made stable at a fixed position during operation including the stopping state where $\theta 1$ and $\theta 2$ are determined to satisfy the above features.

According to this structure, the conveyance roller 108 is pushed to the stable positions of the contact portions (supporting surfaces) 109a, 109b for the bearing to eliminate a loosened space, so that the position of the conveyance roller 108 is merely changed not more than a negligible amount even where temperature changes cause the size changes of the conveyance roller 108 and the bearing 109, and so that the positional accuracy of the conveyance roller 108 is ensured regardless of the circumstances because no loosened situation occurs. Furthermore, addition of parts may be unnecessary, and it can be realized without further costs.

To determine the contact positional angles $\theta 1$, $\theta 2$, the vertical opposition forces N1, N2 produced at the bearing 109, other than above, are

necessarily of positive values (because the conveyance roller may float from the bearing if they are of negative values), and such positive values having some margins are surely selected from a viewpoint to ensure the stability against external disturbances. On the other hand, in consideration of friction and an angle (180-θ1-θ2) between the contact positions 109a, 109b of the bearing 109, the contact positional angles are designed (if the angle becomes smaller, the stability is increased but it is disadvantageous for friction) .

Herein, the contact positions 109a, 109b of the bearing 109 are determined based on merely a resultant vector direction (θt direction) of the vectors Fv1, Fv0 as a symmetric axis. In the conveyance operation, however, since stopping accuracy is the most important factor, the weight to Fv0 may be made larger with respect to Fv1 to improve the stability in a stopping state, thereby producing a resultant vector Ft having a direction closer to the Fv0 side, and thereby determining the contact positional angles θ1, θ2.

In a case where the angle difference between the angles θv1, θv0 is too large to satisfy the condition for determining the contact positional angles θ1, θ2 as described above, in respecting most importantly the stability on a phenomenon (operation) close to stoppage, the contact positions 109a, 109b of the bearing 109 are determined based on a resultant vector direction (θt direction) of, at least, the vector Fv5 exerting on the bearing 109 at a time immediately before stopping and the exerting vector Fv0 in a stopping state, as a symmetric axis. If the condition is permissive, the Fv5 and the Fv1 directions are made closer to Fv4 and the determined target vector, respectively, thereby preferably improving the stability of the conveyance

roller 108 during the operation. The contact positions 109a, 109b of the bearing 109 can also be designed to be closer to the exerting vector direction in the stopping state in those cases.

In this embodiment, the vector Fv0 during stopping with respect to the vector Fv1 exerting on the bearing 109 at a time of the maximum acceleration is the vector most deviated in a positive direction of Y in Fig. 4. In a case where the vector Fv4 and the vector Fv2 are the vectors most deviated in a direction toward the negative direction of Y with respect to the vector Fv1 and toward the positive direction of Y with respect to the vector Fv0, respectively, where the acceleration is large during the accelerating and decelerating periods in order to improve through-put or the like, however, the contact positions 109a, 109b of the bearing 109 are easily introduced by replacing the vectors Fv1, Fv0 used for determining the contact positional angles θ1, θ2 for the bearing, as described above, with the vector Fv4 and the vector Fv2, respectively. With a conventional bearing having an annular cross-section, since the conveyance roller 108 moves greatly, and since the acceleration is large during the accelerating and decelerating periods, introduction of the contact positions 109a, 109b of the bearing 109 as described above can improve the stability of the conveyance roller 108.

Although in this embodiment the bearing 109 has the two surfaces supporting the conveyance roller 108 as shown in Fig. 2 and is formed in a shape covering the peripheral surface of the conveyance roller 108, the bearing 109 is not limited to such a shape. For example, because the portion functioning as a bearing is only two conveyance roller supporting portions

109a, 109b, it is allowable if the rigidity and the shape of the two conveyance roller supporting portions 109a, 109b are maintained, and as shown in Fig. 6, the bearing 109 can be formed as not to cover the top of the conveyance roller 108. With such a bearing shape, assembling can be done by placing the conveyance roller 108 on the bearing 109, so that the apparatus can enjoy merits such as reduction of assembling costs and improvement of maintenance property.

Although in this embodiment the pushing direction of the pinch roller 111 coincides with the gravity direction, it is not necessary to render these so as to coincide with one another. This invention is easily applicable merely by changing the direction of the exerting force vector caused from the pushing direction of the pinch roller 111 even where the pushing direction is inclined for the purpose of pushing the recording medium to a platen serving as a printing facing portion located on a conveyance downstream side, and this does not fall outside of the scope of this invention.

With respect to the drive transmission, although in this embodiment the conveyance roller gear 110 receives only drive from the conveyance motor gear 107a, this invention is easily applicable merely where the conveyance roller gear 110 also serves as a transmitting means for transmitting drive to the delivery roller as well as the feeding means and merely where a load force vector (torque) exerts additionally even where a gear transmitting means is coupled as a load. With respect to the drive transmission method, although the gear transmission method is used in this invention, this invention is not limited to this, and is applicable to a belt transmission or friction transmission. In such

a case, this invention is applicable easily to a formula where the pressure angle $\alpha$ is changed corresponding to the transmission method or tension force of the belt is added. Although in this embodiment, the conveyance mechanism made of the conveyance roller 108 and the pinch roller 111 is described, this invention is easily applicable to a bearing structure for a conveyance mechanism made of the conveyance roller 108 (delivery roller) and spurs where the spurs are used in lieu of the pinch roller 111. It is to be noted that the spur is a rotary body having small contact areas to the recording medium so as not to mess an ink image even where contacting to a surface side on which an ink image is recorded by ink discharge. In this embodiment, it is to be noted that the conveyance surface of the conveyance roller for the recording media and the bearing supporting portion are considered to have the same diameter, but a thinner (having smaller diameter) conveyance roller shaft than the conveyance roller 108 can be used.

[Second Embodiment]

Fig. 7 is a structural diagram of a conveyance roller shaft and a vicinity of a bearing showing features in the second embodiment of the invention as well as an illustration showing exerting forces. The reference numerals and the signs used in the first embodiment indicate substantially the same meanings. In Fig. 7, in substantially the same manner, the conveyance roller 108 is supported at the shaft thereof to the two faces of the contact portions 109a, 109b of the bearing 109. In addition, in this embodiment, the relation between the bearing 109 and the chassis 116 is, in substantially the same manner as above, such that the bearing 109 is supported at the shaft

thereof by the two faces of contact portions ll6a, 116b of the chassis 116, thereby eliminating loosened states between the bearing 109 and the chassis 116, and supporting the bearing 109 stably at a constant position with respect to the chassis 116.

The signs in Fig. 7 have the meanings as follows:

Ft: force that the conveyance roller 108 exerts on the bearing 109 (Ft is an exerting vector sought from the vectors Fv0 to Fv1 exerting on the bearing 109 during each operation during the drive of the conveyance roller sought in the first embodiment);

Fg2: weight of the bearing 109 (perpendicularly downward);

Nc1, Nc2: opposing force of the chassis 116;

Fct: force that the bearing 109 exerts on the chassis 116 (a resultant force of the force that the bearing 109 exerts on the chassis 116 and the weight of the bearing 109);

θct: vector direction angle;

θc1, θc2: contact positional angles between the conveyance roller 108 and the chassis 116.

The combined force of Nc1 and Nc2 is balanced with Fct as the combined vector of Ft and Fg2. Angles θc1, θc2 are determined from this vector Fct with the vector direction (θct) as a symmetric axis. More specifically, the contact positional angles θc1, θc2 are determined so as to render the angle θct direction of the vector Fct to coincide with a direction of a vertically equally dividing line of the line segment coupling the two contact positions 116a, 116b. No restriction exists regarding the angle of the contact positions 116a, 116b of the chassis ll6 in consideration of friction because the bearing 109 does not move rotationally at a space from the chassis 116, but the

angle is set largely to an extent as not to allow the bearing 109 to bite into the chassis 116 due to external force or not to allow positional shifts or deformation of the bearing 109 to occur.

With this structure, during the stop and drive period of the conveyance roller 108, loosened states not only between the conveyance roller 108 and the bearing 109, but also between the bearing 109 and the chassis 116, can be eliminated, thereby ensuring the positional accuracy of the conveyance roller 108 with respect to the chassis 116, and thereby improving further the conveyance accuracy. It is to be noted that with respect to the positional accuracy between the chassis 116 and the bearing 109 in this embodiment, in substantially the same manner as in the first embodiment, it is effective to use determining methods giving the priority to the stopping state, applying Ft, Fct with weights, and shifting toward the exerting force vector at the stop state.

Although in substantially the same manner as in the first embodiment the chassis 116 in this embodiment has the two surfaces supporting the bearing 109 as shown in Fig. 7 and has a shape in a letter of C orienting upward whose top is opened, a portion covering the top of the bearing 109 is not necessary because the portion functioning as a position setter for the bearing 109 is only the two supporting surfaces for the bearing. For example, where the chassis 116 is made in a chassis shape as shown in Fig. 8, the apparatus can enjoy some merits such as reduction of assembling costs and improvement of maintenance property because assembling can be achieved merely by placing the bearing 109 on the chassis 116.

[Third Embodiment]

Regarding the third embodiment of the invention, Fig. 9 shows a structural diagram showing a conveyance roller shaft and the vicinity of a

bearing. The reference numerals and the signs used in the first and second embodiments indicate substantially the same meanings. In the third embodiment, the contact positional angles $\theta c1$, $\theta c2$ between the bearing 109 and the chassis 116 are set to be equal to the contact positional angles $\theta 1$, $\theta 2$ between the conveyance roller 108 and the bearing 109 sought in the first embodiment. That is, the contact portions 109a, l09b for bearing and the contact portions 106a, 106b for the chassis 116 are set to be located on the same line passing the center of the conveyance roller 118. Actually, because in general the mass of the bearing 109 is adequately small in comparison with the mass of the conveyance roller 108, the influence of the weight Fg2 of the bearing 109 is negligible.

Because with this structure the exerting force that the bearing 109 receives from the conveyance roller 108 operates on the chassis 116 with the same angle, a contraction load exerts only on the bearing 109. Therefore, in a case that the bearing 109 is easily subject to load deformation or creep deformation, there are merits that deformation hardly occurs because of exertion of only the contraction load, and the apparatus can prevent the positions of the bearing 109 and the contact positions between the bearing 109 and the conveyance roller 108 due to deformation of the bearing 109 from changing. This structure therefore ensures the positional accuracy of the conveyance roller 108 with respect to external force and the chassis 116 during preservation, thereby improving further the conveyance accuracy.

[Other embodiments]

In the above described embodiments, though a recording means of a serial type is used for description, such as a recording head secured to a

carriage, a replaceable recording head of a chip type, upon an attachment to the carriage, in which ink can be supplied from an apparatus body and in which electrical connection can be made with the apparatus body, and a recording head of a cartridge type, in which an ink tank is formed as a united body with the recording head, can be used.

In addition, although in the above embodiment, the ink is described as a fluid, it can be an ink solidified at room temperature or below as well as softened or liquefied at room temperature, and be an ink liquefied at a time of application of recording signals because in the inkjet recording method it is common to control the temperature so that the ink's viscosity is set in a stable discharging range upon temperature adjustment of the ink itself in a range no less than 30°C and no more than 70°C. Furthermore, this invention is applicable in a case that an ink is used having property that it is liquefied first by thermal energy such that fluid ink is discharged where ink is liquefied upon application of thermal energy in response to recording signals, where increased temperature by thermal energy is positively prevented by use of energy for phase change from the solid state to the fluid state in the ink, or where an ink solidified in a released state is used for the purpose of prevention of ink evaporation, or in any event, and that the ink begins to solidify already at a time reaching the recording sheet.

As a feature of the inkjet recording apparatus as described above, apparatuses used as image output terminal apparatuses of information processing apparatuses such as computers or the like, photocopiers in combination with a reader or the like, and facsimile machines having transmitting and receiving functions can be used.

It is to be noted that although examples using the inkjet recording

method as a recording means are described above, this invention's recording method is not limited to the inkjet recording method, but is applicable to recording methods such as a thermal transfer recording method, a thermal sensing recording method, impact recording methods such as a wire-dot recording method, and any other recording methods. This invention is not necessarily limited to the serial recording method, and a so-called full line recording method can be used for the invention.